Update of the PWR Industry Plan to Address GSI-191

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Presentation Overview

Presentation Outline

- Fracture Mechanics Application
- Debris Generation
- Debris Transport
- Head Loss

Fracture Mechanics Application

Objective:

- Identify and justify the use of a size of a breach piping to be used to evaluate consequential debris generation

Fracture Mechanics Application

Approach:

- A Fracture Mechanics (FM) approach will be used as a basis to define a stable through-wall flaw that, in turn, will provide the basis for evaluating consequential debris generation for loop (hot leg, cold leg, and crossover leg) and surge line piping
- For all other piping break, a complete severing of the pipe will be assumed

Fracture Mechanics Application

Basis:

- Mechanistic evaluations of pipe flaws in primary system piping have been performed:
  - Assess if a postulated instantaneous through-wall flaw would become unstable and lead to an instantaneous complete pipe rupture
  - Evaluations used:
    - Realistic but conservative assumptions, and,
    - Worst case combination of plant loadings

Fracture Mechanics Application

Status

- White Paper submitted to NRC
- Information being added
  - Additional applications
  - Operator responses
  - Licensing background
- Expected completion by July 30, 2003

Debris Generation

Status

- Draft provided to NRC for review
- NRC comments provided
- Draft amended
- Amended draft provided for detailed review

Debris Transport

Guidance:

- To determine the transportability of debris, the velocity of the liquid on the containment floor must be calculated
- Two methods of performing this calculation are presented
  - Hydraulic Network Modeling
  - CFD Modeling

Debris Transport

Hydraulic Network Approach:

- Calculate bulk velocity of liquid moving across the containment floor
- This is done using standard hydraulic network modeling techniques:
  - Segregate the containment into discrete flowpaths
  - The flowpaths are connected by nodes
  - The sump represents a terminal or "sink" node
  - The break represents a supply or "source" node in the network
  - The source node may be moved to represent different break locations
  - Other supply or "source" nodes may be located in the network.

Debris Transport

- Evaluate hydraulic characteristics of each flow path using reference manuals (such as I'delchek) and standard hydraulic practices
- Several options exist for solving the hydraulic network to calculate bulk fluid velocities.
  - Application of a nodal network code
  - Application of an engineering calculation software package, such as TkSolver®
  - Enter the equations into a spreadsheet and solve them iteratively
- Once the velocities in the network are solved for, an assessment of debris transport is made

Debris Transport

CFD Approach:

- A detailed calculation of the flow patterns in the liquid pool on the containment floor may be calculated using a computational fluid dynamics (CFD) code
- The model is constructed using detailed containment geometry information
- This approach provides for detailed local fluid velocities throughout the model region

Debris Transport

Status

- Nodal Network Approach
  - Draft developed
  - Is provided for NRC review
- CFD Approach
  - Development of draft evaluation methodology initiated

Head Loss

Status

- Methodology development initiated
  - Head Loss Equation Formula
  - Limits of Applicability
    - Submerged Screen
    - Partially Submerged Screen
  - Inputs to Head Loss Evaluation
    - Sump Screen Geometry
    - Thermal Hydraulic Conditions
    - Debris Accumulation
    - Debris Bed Morphology

Summary

- Fracture Mechanics:
  - Amended text with additional information scheduled for end of July
- Debris Generation Methodology
  - Amended draft provided for NRC comment
- Debris Transport Methodology
  - Draft of Hydraulic Network Approach provided
- Head Loss Methodology
  - Development initiated